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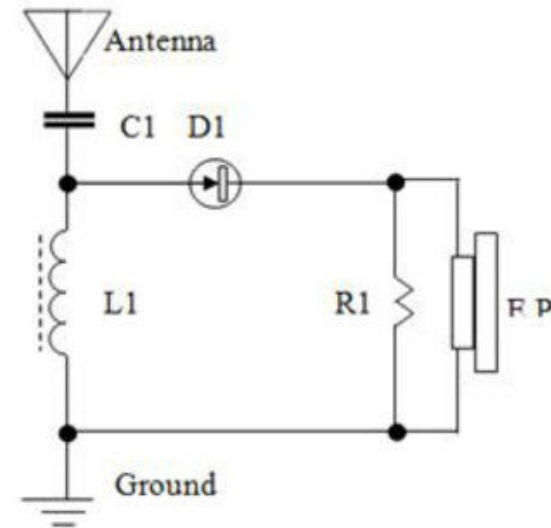
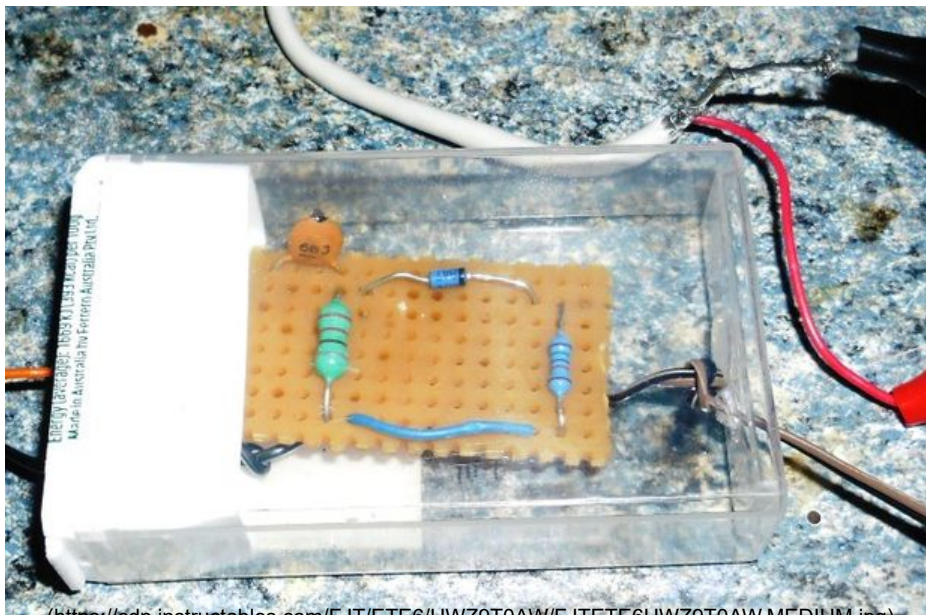
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mk484
(/member/mk484/)
(http://)

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(http://cdn.instructables.com/F8O/QEKG/4X8HK/5/F8O/)

Hi there! **This Instructable is all about building a basic crystal radio set that is so simple to build and understand, that a child could do it - with help from mum or dad - or even at school, as a class project. Parts can be bought**

"off the shelf" at Jaycar Electronics and other suppliers, or purchased online via Ebay and Paypal.

I built my first ever crystal set when I was 9 years old, but that was a different world. We're going to build a 21st century style radio with all modern components which are relatively easy to obtain at your local electronics store or on the Internet.

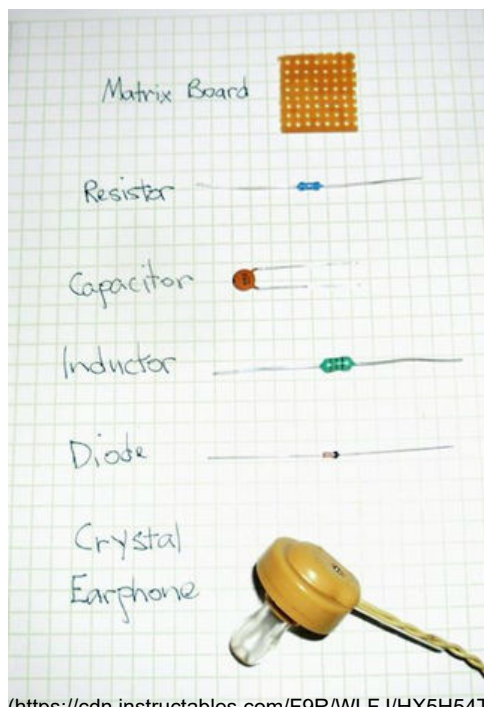
The radio is contained inside a Tic Tac box, and is called "The Nic Nac Tic Tac Radio". It is built on a square of matrix board, with the component leads poked through the holes in the board, and joined underneath. It is a very simple crystal set, designed to initially receive only one station, but you can expand the tuning range with the addition of only one extra component.

The Tic Tac radio can be constructed by simply twisting the component leads together, underneath the matrix board and attaching antenna/ground wires as well as the earphone wires to the board, using that same technique. You don't have to solder any wires, but there is another way to join them all together - more on that later.

The Tic Tac Radio is a very easy set to put together - you don't need to wind bulky coils or use heavy tools and screw strange looking parts onto a large breadboard. See step 1 for the parts list you will need.

Bio: Started as a hobbyist at 9 - built my first crystal radio on one of mum's prized cutting boards (eek) - Worked in 2 electrical/electronics ... More »
(/member/mk484/)

Step 1: Parts and Tools You Will Need



You will need to acquire the following components from a local electronics shop or an online electronics business.

I am adding the catalogue numbers for Jaycar Electronics, so if you live in Australia or North America, you may be able to visit a Jaycar store and buy the parts over the counter, if not then you may be able to do an online mail order via Paypal:

Parts List

Resistor - 47k - yellow-purple-black-red and brown - RR 0612 (pkt of 8)

Capacitor - 68pF - ceramic x 2 - RC 5322 (pkt of 2) and a 100 or 120 pF value as well for experiments.

Inductor - 220 uH - red-red-brown silver - LF 1538 (resistive type)

Polyvaricon tuning capacitor - 220 pF - RV 5728 - with knob and mounting screws

Diode - BAT46 - ZR 1141 (You can also use a 1N34A Germanium Diode too if you have one at home)

Ceramic Earphone - AS 3305 *

A 25 meter roll of yellow hook up wire for the Antenna wire and a 3 meter length of wire for the Ground wire.

Please note that some Jaycar parts come in multiples of 2 or more per packet. And please note the following:

PLEASE NOTE: THIS PROJECT/KIT CONTAINS SMALL PARTS THAT MAY FORM A CHOKING HAZARD FOR SMALL CHILDREN OR PETS. NOT SUITABLE FOR CHILDREN UNDER FIVE (5) YEARS OLD.

*A normal crystal radio earphone is OK, but if you can't get one of these, or if the one you bought goes dead (as they sometimes do,) you can use a substitute, such as the Murata PKM44EW passive transducer (see picture above) which is available from an old Telstra TF200 touchphone, (the one on the left in the diagram above,) or an equivalent, such as the ARIO transducer, from an old Telstra T1000 pushbutton phone.

The ARIO unit is soldered to the phone's pc board so you'll need to be able to unsolder the three mounting pins underneath the board, or find someone in the neighbourhood who is able.

Take the back off the TF200 (if you've obtained one of these phones,) and you'll see a black disc shaped object 2" round by 1/2" thick - with a red and black wire. Unplug the wires from the circuit board, and unscrew any retaining screws and remove the transducer. Cut the mini plug off, **carefully** strip the insulation from the ends of the wires and extend them by about 18" with 2 thin lengths of hookup wire. These piezo devices make good earphones for crystal sets and can be housed in an old pair of ear muffs.

Miscellaneous Materials:

A Tic Tac box (smaller size)

A piece of matrix board at least 7 holes long by 8 holes across. Cut the board to fit neatly inside the Tic Tac box.

A short length of 2 differently coloured wires 60 mm in length and 2 crocodile clips with red and black plastic covers

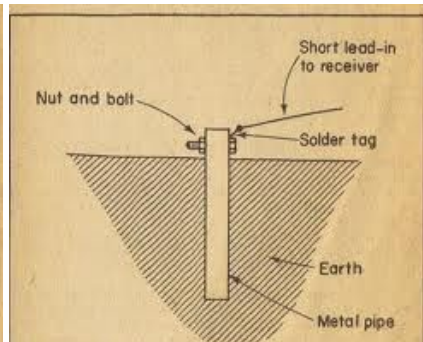
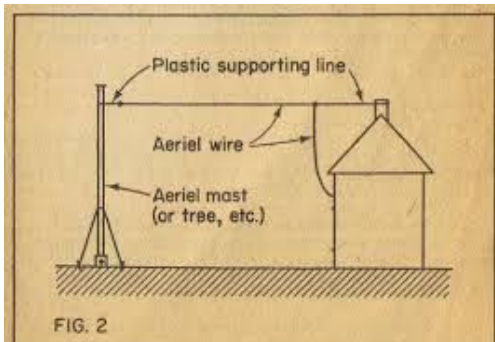
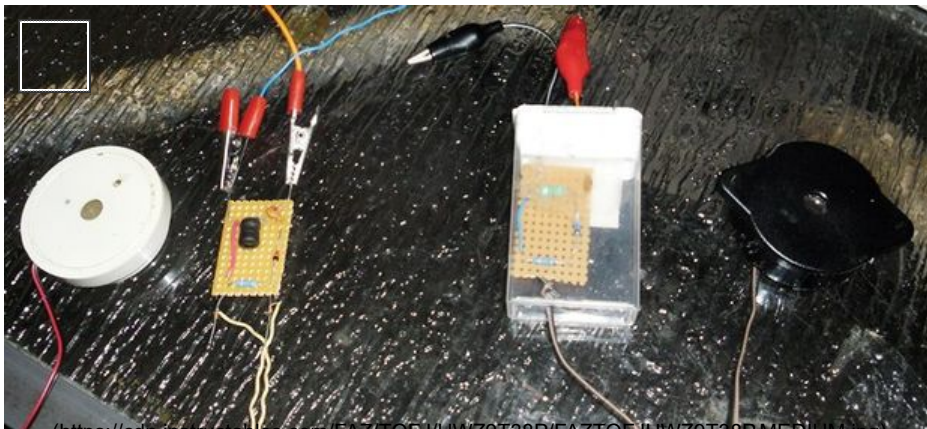
A length of antenna wire at least 25 metres long and a 3 metre length of a different colour for the Ground wire.

A metal rod or cold water pipe for the ground stake. **Be careful which pipes you connect your Ground wire to.**

You will need a small sharp object for punching holes in the Tic Tac box.

A small pair of wire cutters for cutting and stripping wires.

Step 2: How a Crystal Radio Works



Radio signals consists of two parts - the 'carrier wave' which is the AM radio station's frequency of operation, and the 'program signal' which is mixed with the carrier wave for transmission.

Radio waves travel out from the AM transmitter tower through the atmosphere. We want to capture one specific frequency so we can listen to it, so we need the antenna/ground wire system to capture that signal. We also need a 'tuned circuit' that will filter out the desired AM signal, and discard the rest, so that all the other unwanted radio signals pass out through the ground wire to earth.

Two components in our circuit will perform that task for us. The **capacitor** C1, together with L1 **inductor**, form a basic 'series tuned' circuit. Their respective values will determine just which local AM radio station we will capture.

We also need a **diode** to 'detect' the voice and music, so we can hear them in our **earphone**, which transduces electrical signals into sound waves that we can hear.

In the photo above you can see a completed Tic Tac crystal radio. It is already inside the box. The other set is connected to the antenna/ground wire circuit, undergoing a 'soak test'. It is necessary to do this to ensure that the radio will work once inside the box!

The first diagram shows a typical antenna wire installation. Coming out of a window, the wire is anchored to the building and then over some distance (10 metres +) to a nearby tree or other building.

You must take great care not to erect antenna wires near to power or telephone cables, near your home!

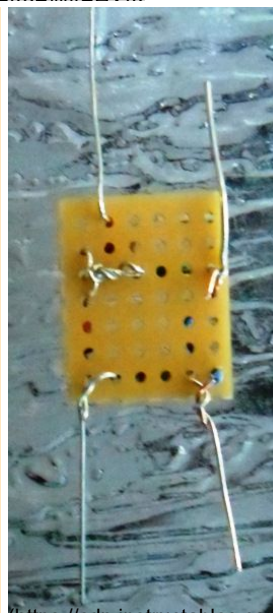
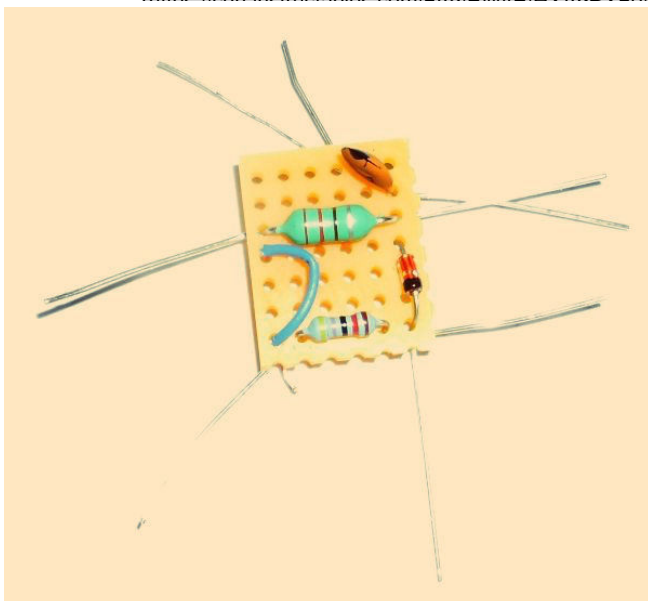
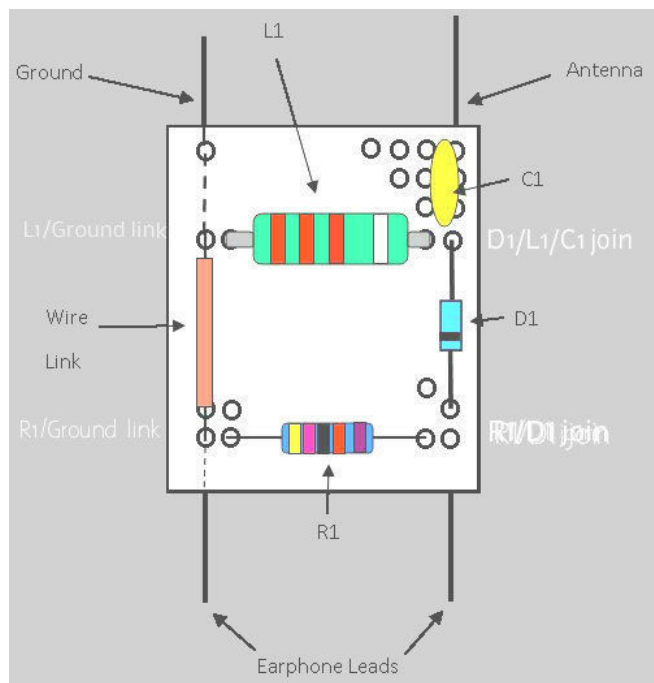
The ground wire comes out the same window and is anchored to a metal pipe/water pipe or metal ground stake, embedded in soft, moist soil.

You must not connect ground wires to electrical mains wiring installations, including wall power outlets!

Another electrical hazard to consider is **lightning strikes!** Although it is very rare for anyone to be seriously injured or die from a lightning strike it is **not impossible**. So, if you hear a thunderstorm coming your way (you may hear the lightning 'crashes' in your earphone first,) then **disconnect your antenna wire immediately**, connect it to the ground wire and put it well up out of the way.

Stay well clear of this temporary antenna/ground connection until the storm has completely passed away from your general area - miles away!

Step 3: How to Build the Tic Tac Crystal Radio Set



1. Take the components and lay them out on a clean surface.

2. Take the square of matrix board (this is also called 'perf board' because of all the holes or perforations in the material) and beginning with the 220uH (uH = micro-Henry) and place it as shown in the diagram.

3. Then take the diode, capacitor and resistor and place them in the places shown for them, making sure that the coloured band at one end of the diode joins with the resistor wire, as shown

4. Then take each junction where wires come together through their respective holes and gently twist them together, until they form a neat, tight bundle. Take your side cutters and cut off any excess length, taking care not to cut any one wire too short, so that it comes undone from the join.

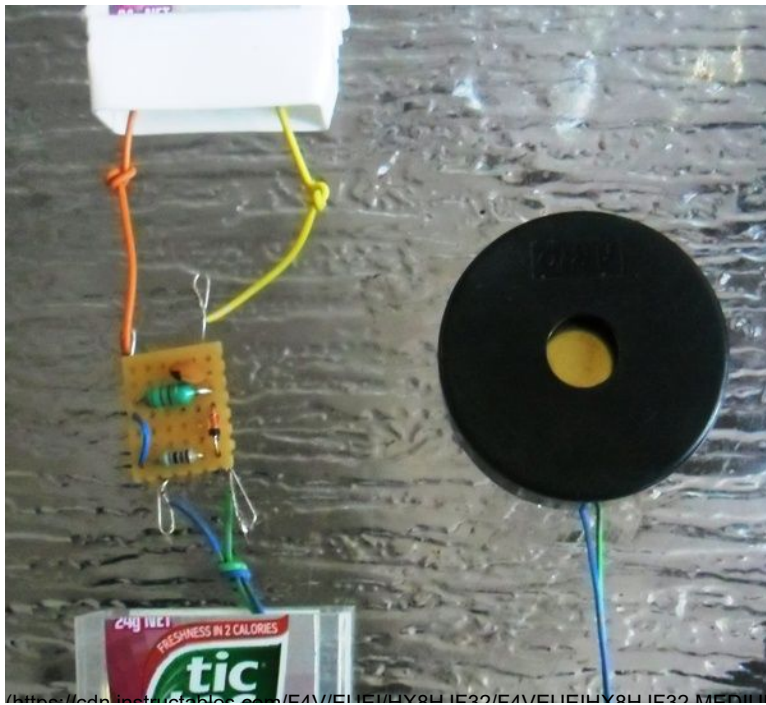
5. Take the link wire, strip 2 centimetres of insulation from each end of the wire and install that wire between the free ends of the inductor and resistor, and the matrix board construction is complete.

6. Then take the ceramic earphone, cut the plug off the end, and strip the 2 wire ends about 1.5 centimetres in length. Wrap each earphone wire around each end of the resistor component, underneath the matrix board.

7. Finally, strip the insulation off both ends of the 60mm long differently coloured wires, and attach them to the matrix board - one goes to the inductor/link wire junction and this will be the Ground connection wire. Attach the other one to the free end of capacitor C1 and this will be the antenna wire connection. Both connections are made underneath the matrix board. The Nic Nac Tic Tac Crystal Radio is now ready for testing.

Step 4: Final Checks and Installation of Wires



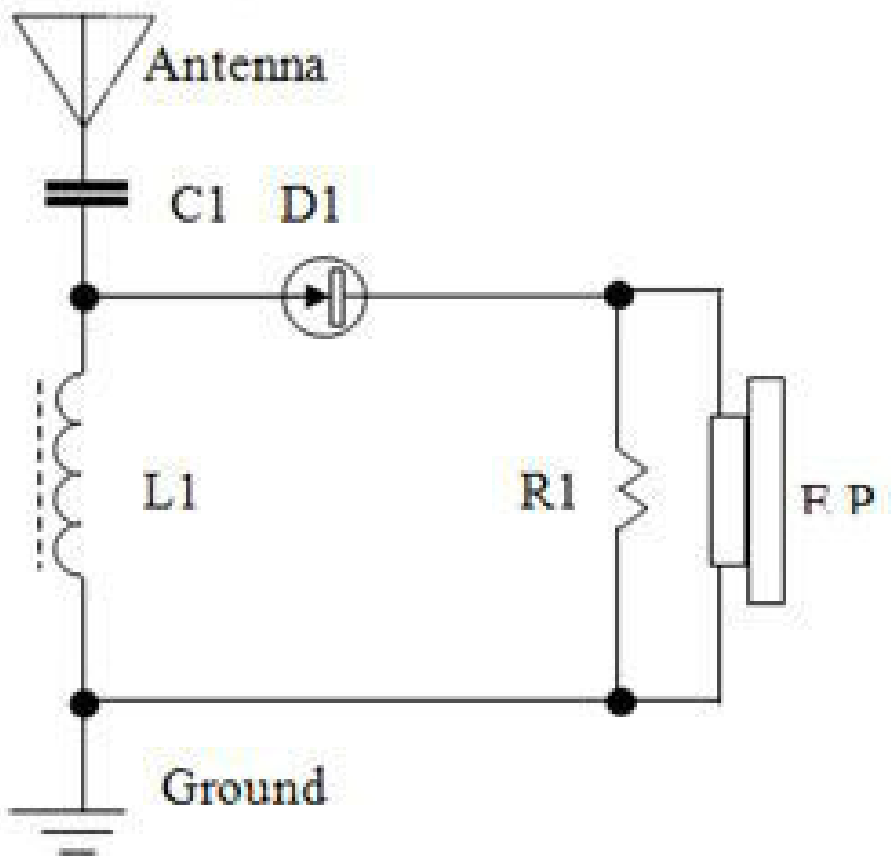
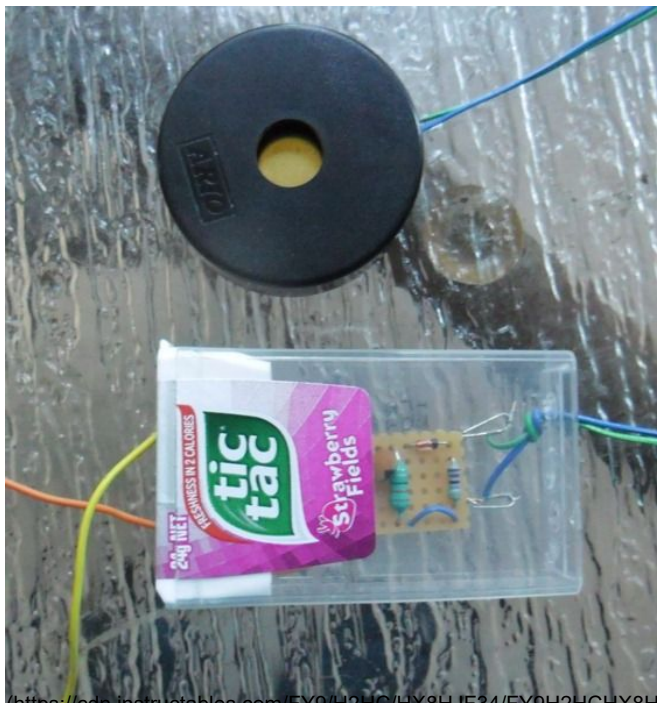


When you've finished constructing the matrix board circuit and have clipped all the excess component leads off, puncture three (3) holes in the Tic Tac box - 2 small holes on the top lid of the box, about an inch (24mm) apart, so that your antenna and ground wire leads can come through the box lid, and be connected to the matrix board at those 2 points.

Feed the wires through the holes and then tie small knots in each one, near the underside of the box lid, so that they won't pull back out if strained, and disconnect themselves from the matrix board.

Then make one larger hole in the centre of the bottom of the box (clear part) so that your earphone wires can be fed through to the connecting points on that part of the matrix board. Tie a larger knot in the earphone lead so as to prevent it from pulling out of the box if it is strained. Strip the insulation off the earphone leads, and wrap them around the matrix board leads at those 2 points. You are now ready to test out the Nic Nac Tic Tac Crystal Radio.

Step 5: Testing Out the Tic Tac Radio



<https://cdn.instructables.com/FI641C1/4Y5E5FA2/FI641C1/4Y5E5FA2-MEDIUM.jpg>

Take your finished Tic Tac Radio (with the lid part gently pushed back inside the top of the box) and connect your Antenna and Ground wires to the lead outs from the box lid. Place the earphone in/over your ear, and listen carefully for a local AM radio station. This crystal radio is a simple one, and you may have to make one or two adjustments to the components, before you succeed in receiving one or more local AM radio stations, in your area.

Make sure that your antenna and ground wires aren't snagged on anything metal or anything **dangerous!**

If you have ANY doubts about the electrical safety of your antenna or ground wires, then consult a licensed electrical trades person, who will be able to advise you on electrical safety principles and procedures!

Always remember that electrical safety is your responsibility! If you don't think it is safe to proceed, then don't!

You will need at least 10 to 15 metres of antenna wire, strung between 2 insulating points (not connected to anything metallic, or that gets wet,) at least 2 to 3 metres in height - anything less than this minimum arrangement may mean that you cannot receive any signals at all.

Some places are regarded as 'radio dead spots', so you may need to try an open space, such as a park or a remote corner of a beach. If you do erect antenna and ground wires in public places, hang some streamers or balloons off of them, to alert people to their presence, otherwise people going past may become entangled with them - and get cranky with you!!!

As a final word for now, you'll be happy to know that the completed "Nic Nac Tic Tac Radio" shown in the picture above, picked up local AM radio station **1116 khz 4BC** here in Brisbane, with a very clear signal and quite good volume. It works! So be safe kids, have some fun and look forward to more... mk484

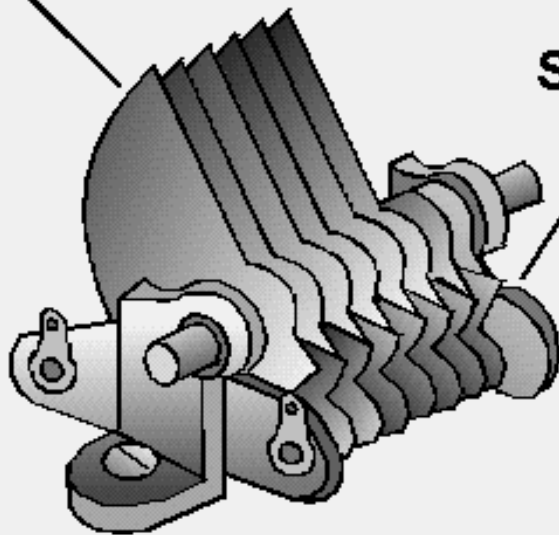
Step 6: Nic Nac Extras



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ROTOR

STATOR



SYMBOL

<https://cdn.instructables.com/EB1/AV42/4Y84K020/EB1/AV42/4Y84K020/MEDIUM.gif>

If you've built your Tic Tac crystal set and found that you can't receive a local AM radio station yet - don't panic - help is in on the way. You have just built the simplest version of the Tic Tac crystal radio and you may need to add one more component part for it to work properly. This is called a 'polyvaricon' - a miniature tuning capacitor, which can vary the frequency that your radio will receive at. You can see a picture of one up above - the small white box with the black knob next to it. It has 3 connecting tags - the one in the middle ('G') goes to the moving plates and the shaft, while the 2 outer tags ('O' and 'A') go to 2 sets of fixed plates. the smaller set of plates has a value of 60pF - pF is short for 'picoFarad' - a unit of measurement for capacitance. The larger set of plates is valued at 160 pF so that the combined value of the polyvaricon is 220 pF - or 220 picoFarads.

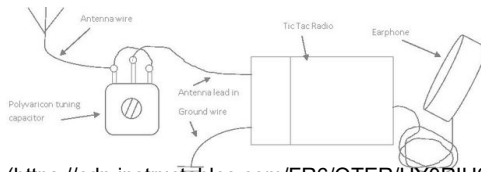
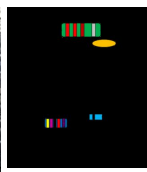
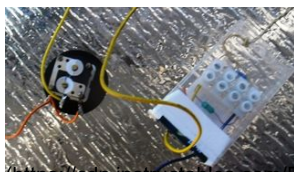
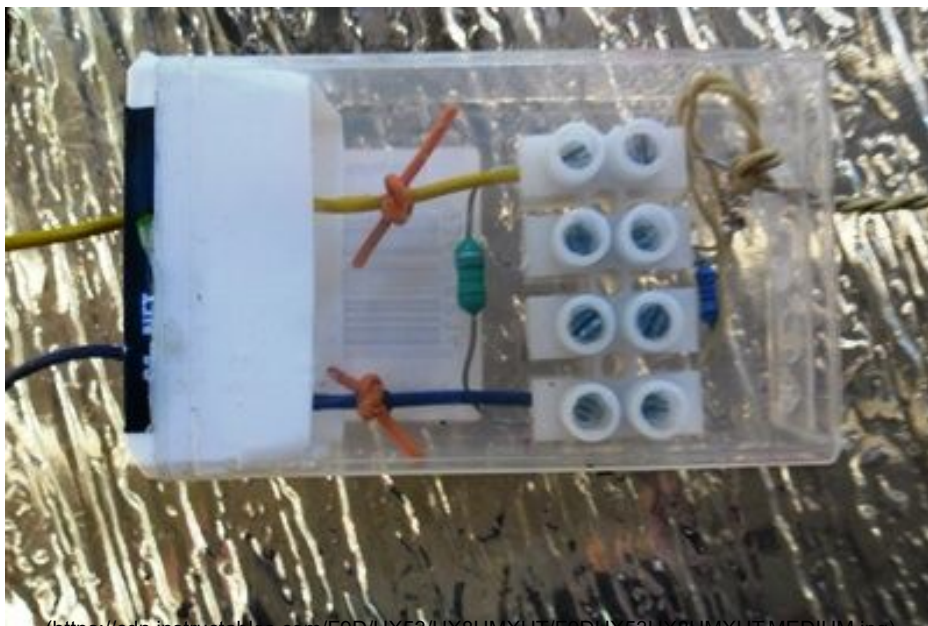
The other picture shows you what happens inside a basic tuning capacitor. there are 2 sets of metal plates - one set is fixed and the other set moves on a rotating shaft, connected to the tuning knob of your radio set. Both sets of plates are mounted on an insulating frame so that they won't 'short out' by touch each other.

The fixed capacitor C1, was chosen to tune somewhere close to the middle of the AM radio band. This band of frequencies starts at 531 kilohertz (Khz) and goes as far as 1701 Khz here in Australia. So we need a combination of coil and capacitor which will tune across all of those frequencies. Our simple Tic Tac radio is known as a 'series tuned' set. If you look at the circuit diagram, you can see electronic symbols for all components in the radio set. If you start at the top with the antenna symbol, you can see the capacitor C1 underneath that, the inductor L1 underneath C1 and then finally, the ground symbol - all wired in series with each other.

The diode D1 detector, the resistor and the earphone plus the link wire, can be considered as one block - the "detector unit". The Antenna wire, ground wire, inductor/coil and capacitor/polyvaricon, can be also be considered as another

block - the "tuned circuit". So joining both blocks together, we have the tuned circuit that tunes in only one frequency, passing all other unwanted signals out through the ground wire to earth. This one 'tuned frequency' passes through the diode detector, which strips away the 'carrier wave' and leaves only the 'program signal' (voice, music etc,) behind, which is then fed via the resistor into the earphone. The earphone changes electrical impulses from the diode detector, into sound waves that we can hear. You need the R1 resistor to provide a pathway for the signals going through the diode, out to the ground wire connection. Without this resistor, the signals would sound very distorted and you couldn't hear the program signal very clearly.

Step 7: Adding the Polyvaricon Tuning Capacitor



If you want to expand the tuning range of your Tic Tac Radio, than all you have to do is a simple modification (change) to the circuit of your radio set. You can see from the 2 pictures above, that there's an alternative way of building the crystal radio - you can use the matrix board method or you can use a 4 way screw terminal strip.

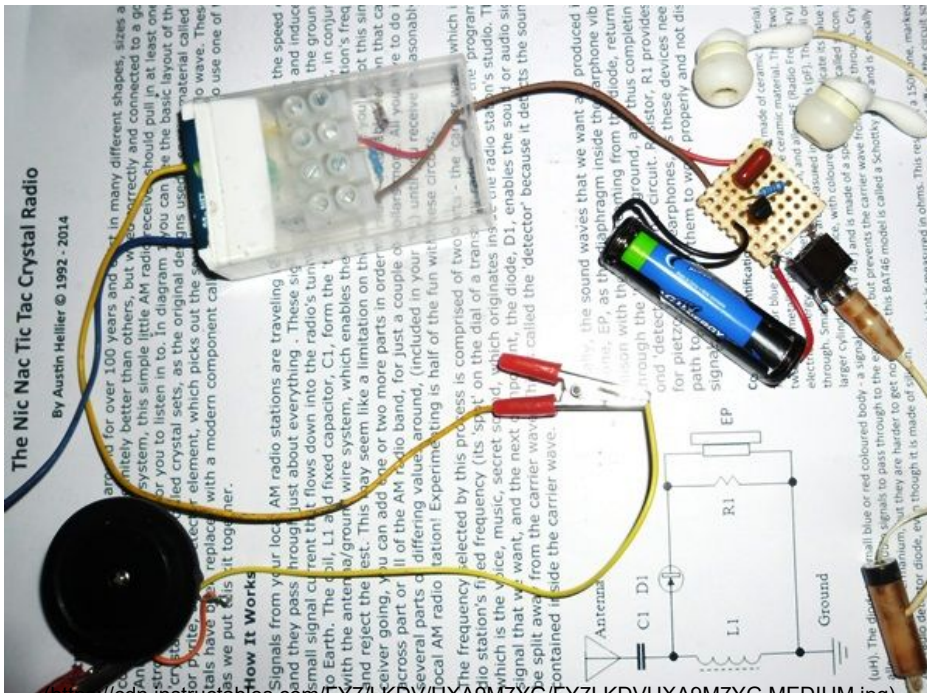
To use the screw terminal version, cut yourself a 4 way strip of terminals as shown in the diagram and pictures. Undo the screws right out as far as they will go without falling out of the strip. Connect the component leads and wires from the antenna/ground system as well as the earphone wires. Cut off any excess from component leads that you don't need. Wrap thin wires from the antenna/ground system and the earphones, around the thicker component leads before screwing the screws in tight.

Regardless of which method you have used, all we will now wire up the tuning capacitor between the actual Antenna wire and the junction (join) where the diode D1, the fixed capacitor C1 and one end of the inductor meet. Remove the capacitor from the matrix board, and connect the Antenna lead out wire straight to the join of the diode and inductor. Then take the polyvaricon and another

piece of wire. Strip both ends of that wire and join the two outer tags (tagged 'O' and 'A' - the centre one is tagged 'G') and then connect your actual Antenna wire to one of the outer tags. Connect the antenna lead out wire, coming out of the box, to the 'G' (middle) tag of the tuning capacitor, so that the antenna wiring now looks like the picture up above.

If you're having problems following the pictures, then refer to the diagrams, which clearly shows all of the connections. Make sure your ground wire is connected to the set, and then, listening with your earphone in/over your ear, slowly turn the tuning cap's flat knob, until you hear one or more stations. Congratulations - you now have a "tuneable" Tic Tac crystal set! Happy listening! And don't forget to post your results, questions, problems etc... mk484 :)

Step 8: Tic Tac One Transistor Amplifier - Use Your Earbuds and Hear Great Sound...



Hi there folks - this isn't really an extra 'Step' as such - it's a sneak preview at a picture of my upcoming Instructable for a one transistor amplifier, which will connect to the Tic Tac Radio - and give you some really good volume - in your Iphone earbuds!

Yes, it's entirely possible nowadays, with modern circuit design, to fit a one transistor amp in such a small space (yes kiddies - it WILL fit inside the smaller Tic Tac box...) and at the same time, get that great sound that comes from those "inside your ear" type earbuds.

This circuit took me about a half hour to complete, uses only 3 electronic components, costing about \$1.00, a stereo earphone jack and a 1.5 volt AAA battery and plastic holder costing about another \$3 to \$4, so you can build the amplifier for about \$5 all up - don't forget to shop around and - mums and dads - cheap batteries will be OK for this project, and the battery can simply be replaced without soldering or undoing half a dozen screws....

I can hear my Tic Tac Radio with great volume and clarity - and so will you, so "stay tuned" (ha ha ha) to this series of Instructables, and you will hear great sound too...



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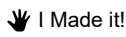
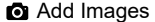
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Comments





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Please be positive and constructive.



Colaris (/member/Colaris/)

2014-10-29

[Reply](#)

Can't you use regular headphones for both ears?



mk484 (/member/mk484/) ▶ Colaris (/member/Colaris/)

2014-10-29

[Reply](#)

Hi Colaris - earphones for crystal radios need to exhibit a fairly high impedance to the circuit (diode end and ground) - in the order of 2 to 4,000 ohms, as a bare minimum.

Low impedance phones (8 to 64 ohms like your average earbuds/large headphones) won't have anywhere near the impedance required. Trying to drive a low impedance 'load' such as a pair of earbuds, is like trying to drive a mains powered with a 9 volt battery - it's not going to happen...

While crystal earphones or the Murata substitute may not be perfect, they are more than adequate for kids and adults who are just experimenting with basic radio receivers.



mk484 (/member/mk484/) ▶ mk484 (/member/mk484/)

2016-01-16

[Reply](#)

Hi Colaris - what I meant to say was that

"Trying to drive a low impedance 'load' such as a pair of earbuds, is like trying to drive a mains powered (toaster) with a 9 volt battery - it's not going to happen..."



TravisM18 (/member/TravisM18/)

2015-11-03

[Reply](#)

I think you may need a tuning capacitor in there some where?



nupogodi (/member/nupogodi/)

2015-09-10

[Reply](#)

It is so pitty that in the near future all AM radiostations at least in USA and European Union will change to digital modulation so those amazing constructs will become useless :-(



mk484 (/member/mk484/) ▶ nupogodi (/member/nupogodi/)

2015-09-12

[Reply](#)

There are no plans to dump off AM or FM radio here, or in many other countries. Singapore has gone all digital but many other Asian countries are keeping their AM and FM transmitters for now



mk484 (/member/mk484/)

2015-07-15

[Reply](#)

Hello there - can any body tell me if they actually built this Tic Tac crystal radio, and if so, how did you go with it?

Thanks

MK484 :)



ViktorV1 (/member/ViktorV1/)

2014-09-28

[Reply](#)

So is there any way to have a smaller antenna or less grounding for this setup? I was thinking of making a "walkie-talkie" type thing with this and a simple AM transmitter. Are there things I can add to the circuit that would reduce the need for a big stationary antenna?



mk484 (/member/mk484/) ▶ ViktorV1 (/member/ViktorV1/)

2014-09-28

[Reply](#)

Hi Viktor - if you live really close to an AM transmitter or two, you could try a 2 foot length of very thick pvc covered wire as a portable antenna. You may still need a ground wire though. Walkie talkies on the AM band would tend to be very noisy though.



mk484 (/member/mk484/)

2014-07-10

[Reply](#)

Thanks to everyone who has marked this project as a favourite



jessyratfink (/member/jessyratfink/)

2014-07-08

[Reply](#)

What a neat build - I could see this getting assembled in schools really easily. :D



mk484 (/member/mk484/) ▶ jessyratfink (/member/jessyratfink/)

2014-07-08

[Reply](#)

Hi jessyratfink - I "invented" the Tic Tac xtal radio back in 1992 and used to sell it as a kit at flea markets - I also ran classes as a one of at a local community centre for adults. One little old lady who came and built her set, used a curtain rod in her kitchen as the antenna and the cold water tap in the sink as her ground. She told me that she used to sit there each night and listen to the ABC and smile whenever she reminded herself that SHE built it!



mk484 (/member/mk484/)

2014-07-07

Reply

Hi folks - the Tic Tac Radio article is finished - no more mods or additions for now, so feel free to post in with questions, problems in building your radio etc - mk484



mk484 (/member/mk484/)

2015-11-03

Reply

Hi Travis - this set was designed as a basic 'bare bones' one for the beginner. In the later construction pages, I do add a small polyvaricon tuner cap in place of the fixed ceramic cap so you can vary the frequency you can receive at.

The set is wired to be 'series tuned' so reception may not be perfect at first, but you can experiment with the height and length of the antenna wire to try and get better reception - eg: more stations or better volume.

ALWAYS REMEMBER FOLKS TO CHECK OUT THE ELECTRICAL SAFETY OF YOUR ANTENNA AND GROUND WIRE SYSTEMS BEFORE CONNECTING YOUR CRYSTAL SET TO THEM...



charris8 (/member/charris8/)

2015-10-15

Reply

Do you really need it grounding? What are the chances of an electrical surge from a non powered device?



mk484 (/member/mk484/) ▶ charris8 (/member/charris8/)

2015-10-15

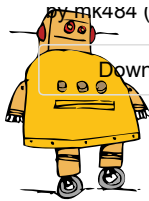
Reply

Hi - a ground wire provides a return path so that the AM radio signal can be fully received by the set. If you leave the ground wire off, you may not get very good volume in the earphone, or worst still, you may not get a signal at all.

You need to install a safe ground wire - one that goes straight to a metal pole, embedded in soft, wet soil. Make sure there are no pipes or cables underneath the ground where you are going to do this. If you have any doubts, consult a qualified electrician who can advise you on how to do that safely.

As for electrical shocks, they are possible during thunderstorms, due to potential lightening strikes, so it's best to disconnect your crystal set from both the antenna and ground wires for the duration of the storm. Quite often you can hear the 'crackle' of distant thunder/lightening in the distance, long before you can see/hear them.

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